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Patent
Attorney's Docket No. 024444-424

09/15/91 U.S. PTO

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY PATENT
APPLICATION TRANSMITTAL LETTER

Box PATENT APPLICATION

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed for filing is the utility patent application
of 1) Mattias BERGLUND, 2) Fredrik LUNDBERG, 3) Ingela SVENSSON
for **TWO-PIECE ROTARY METAL-CUTTING TOOL AND
METHOD FOR INTERCONNECTING THE PIECES**.

Also enclosed are:

- Four sheet(s) of [] formal Informal drawings (FIGS. 1-9);
- a claim for foreign priority under 35 U.S.C. §§ 119 and/or 365 in [] a separate document the declaration;
- [] a certified copy of the priority document;
- [] an Associate Power of Attorney;
- [] --- verified statement(s) claiming small entity status;
- [] an Assignment document;
- Information Disclosure Citation (PTO-1449); and
- [] Other: _____

The Executed declaration of the inventor(s) [] also is enclosed will follow.

The filing fee has been calculated as follows [] and in accordance with the enclosed preliminary amendment:

CLAIMS					
	NO. OF CLAIMS		EXTRA CLAIMS	RATE	FEE
Basic Application Fee					\$ 770.00
Total Claims	15	MINUS 20 =	---	x \$22 =	---
Independent Claims	4	MINUS 3 =	1	x \$80 =	80.00
If multiple dependent claims are presented, add \$260.00					---
Total Application Fee					850.00
If verified statement claiming small entity status is enclosed, subtract 50% of Total Application Fee					---
Add Assignment Recording Fee of \$40.00 if Assignment document is enclosed					---

TOTAL APPLICATION FEE DUE	850.00
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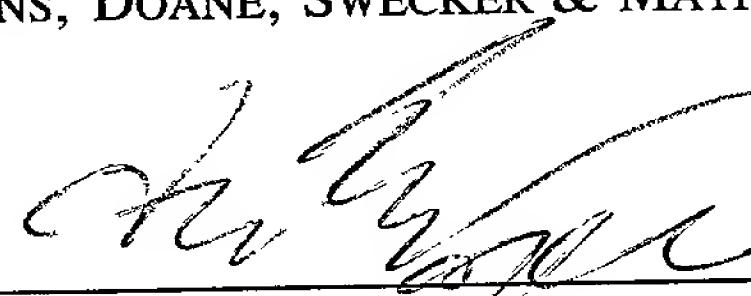
A check in the amount of \$ 850.00 is enclosed for the fee due.

Charge \$ _____ to Deposit Account No. 02-4800 for the fee due.

The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§ 1.16, 1.17 and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. This paper is submitted in triplicate.

Respectfully submitted,

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By: 
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Date: September 15, 1997

**TWO-PIECE ROTARY METAL-CUTTING
TOOL AND METHOD FOR INTERCONNECTING THE PIECES**

Background of the Invention

The present invention relates to a tool for rotary, cutting machining, comprising a tool body and a cutting portion. The tool body has a front surface, and the cutting portion has a support surface provided to releaseably abut against the front surface in a substantially radial plane. The tool body and the cutting portion comprises means which cooperate for holding them together. The invention also relates to a cutting portion and a tool body as well as a method for mounting a cutting portion to a tool body.

Prior Art

It is previously known to use interchangeable cutting edges on different types of tools for cutting machining, especially when cutting a metallic workpiece. This technique however has practical limitations due to handling reasons when it comes to milling and drilling tools which rotate around a longitudinal axis.

Through DE-PS-367,010 and Burger U.S. 2,259,611, it is previously known to provide drills with lockable drill tips, wherein the drill tip is retained with the aid of dove-tail profiles or with press fit, respectively. The known tools however are impaired with drawbacks such as bad torsion transferring ability and troublesome mounting and dismounting.

The present invention has as one object to provide drilling and milling tools with interchangeable cutting edges, which eliminates problems associated with known techniques.

Another object with the present invention is to provide a rigid tool preferably for drilling or milling wherein the cutting portion cooperates with the tool body via a bayonet coupling.

5 Another object of the present invention is to provide a rigid tool preferably for drilling or milling wherein the cutting portion can be easily exchanged by hand without time consuming screwing or soldering.

10 Another object of the present invention is to provide a tool with a self centering cutting portion.

Summary of the Invention

These and other objects have been achieved by the present invention which relates to a rotary metal-cutting tool comprising, in combination, a tool body and a cutting portion attached to the tool body. The tool body includes a shank portion defining a longitudinal center axis, a front surface, and rear chip flutes formed in an external side surface of the shank portion for guiding chips rearwardly during a cutting operation. The cutting portion includes a rear support surface abutting the front surface, a front cutting face, and front chip flutes formed in a side surface of the cutting portion and intersecting the cutting face to form cutting edges therewith. The tool body and cutting portion are interconnected by a bayonet coupling formed by projections disposed on one of the tool body and cutting portion, and recesses formed in the other of the tool body and cutting portion. The projections are circumferentially offset with respect to the flutes and extend generally longitudinally. The recesses extend circumferentially from respective flutes. The flutes are sized to longitudinally receive respective projections during longitudinal insertion or removal of the cutting portion relative to the tool body. The cutting portion is rotatable about the center axis relative to the tool body.

to transfer the projections from the respective flutes and into the recesses while bringing the front flutes into alignment with the rear flutes.

The invention also relates to a method of
5 mounting a cutting portion to a tool body to form a metal-cutting rotary tool. The tool body includes a shank portion, a front surface, and rear chip flutes formed in an outer surface of the tool body. The cutting portion includes a support surface abutting the front surface, a cutting surface having cutting edges, and front chip flutes formed in an outer surface of the cutting portion. One of the tool body and cutting portion includes longitudinal projections, and the other of the tool body and the cutting portion includes circumferential recesses.
10 Each recess communicates with a respective flute and extends less than 180°. The method comprises the steps of:
15

20 A) converging the cutting portion and tool body longitudinally toward one another to bring the projections into respective ones of the flutes that communicate with the circumferential recesses; and

25 B) effecting relative rotation between the tool body and cutting portion to cause the projections to enter respective ones of the recesses to bring the front flutes into alignment with the rear flutes and to bring a stop surface of each projection into longitudinally opposing relationship with a stop surface of a respective recess for defining a bayonet connection preventing longitudinal displacement of the cutting portion relative to the tool body.
30

Description of the Drawings

The objects and advantages of the invention will become apparent from the following detailed description of a preferred embodiment thereof in connection with the

accompanying drawing in which like numerals designate like elements, and in which:

FIG. 1 shows a drilling tool according to the present invention, in an exploded perspective view;

5 FIG. 2 shows a cutting portion according to the present invention in a bottom view;

FIG. 3 shows the cutting portion in a sectional view taken along the line III-III in Fig. 2;

10 FIG. 3A shows the cutting portion in a perspective view from below;

FIG. 4 shows the forward end surface of a tool body according to the present invention in top view;

FIG. 5 shows the drill shank in a sectional view taken along the line V-V in Fig. 4;

15 FIGS. 6, 7 and 8 show cross-sections of a bayonet coupling of the tool;

FIG. 9 shows the assembled tool according to Fig. 1 in a magnified side view.

20 Detailed Description of a Preferred Embodiment of the Invention

The embodiment of a tool 10 according to the invention shown in Fig. 1 is a so called helix drill, which comprises a cutting portion or drill tip 11 and a drill body 12. The drill has a rotational direction R.

25 The drill tip 11 is provided with at least one cutting edge 19 in the forward end thereof facing away from the drill body 12, which tip is given different designs depending on the area of application.

30 The drill tip 11 is made of hard material, preferably cemented carbide and most preferably of injection molded cemented carbide, and comprises a front cutting surface formed by two upper clearance faces 15, a lower support surface 16 as well as first and second curved surfaces 41, 18 interconnecting the surfaces 15 and 16. All these surfaces and associated edges

are integrated as one piece with the drill tip and consequently formed of the same material, i.e. preferably injection molded cemented carbide. The curved surfaces 18 form front chip flutes for conducting cuttings rearwardly. 5 Lines of intersection between the chip flutes 18 and the clearance faces 15 form main cutting edges 19, preferably via reinforcing chambers, not shown. Lines of intersection between the first curved surfaces 41 and the chip flutes 18 form secondary cutting edges 19'. The chip 10 flute is shown as helical but may alternatively be adapted for a drill body requiring straight chip flutes. The radially external parts between the chip flutes consist of protruding lands formed by the surfaces 41, each having a circumferential length G (Fig. 4). The largest diameter 15 of the drill tip is the diametrical distance between the radially extreme points of the secondary cutting edges. The height of the drill tip is substantially the same as the largest diameter of the tip, in order to minimize the wear from chips on the joint between the drill tip and the 20 drill body. Flushing holes 23, extending substantially parallel with the rotational axis 22, extend through the drill tip from the support surface 16 to the orifice in respective upper clearance surface 15.

The support surface 16 according to Figs. 2, 3 25 and 3A is substantially planar but comprises a recess 50 at the transition between the support surface 16 and the land 41. Each recess 50 comprises a first free or end surface 51 perpendicularly connected to both the land 41 and a second free surface 52 (see Fig. 8), which surface 30 52 in turn forms an acute angle α with a first guiding surface 53 (see Fig. 6). The surface 53 connects to a second guiding surface 54 oriented parallel to the rotational axis 22, and which connects to the support surface 16 via a radius or an entering bevel 55. The 35 surface 53 is inclined obliquely relative to the center

axis 22 so as to face generally radially inwardly and longitudinally rearwardly. The recess 50 has a stop surface 56 (Fig. 3A) which is parallel to the axis 22 and which suitably lies in an axial plane which intersects said axis. The recess 50 extends in a tangential direction from the chip flute 18 to about a midpoint of the circumferential length G of the associated land 41.

The drill body is made of a material which has a lower Young's modulus than cemented carbide. The drill body has helical rear chip flutes 18A (or straight chip flutes if required) and these can extend along the entire outer surface of a shank portion 40 of the body or along only a part thereof. The drill body 12 is provided with a front surface 24 at the end facing towards the drill tip 11, which surface 24 abuts against the support surface 16 of the drill tip 11. The largest diameter of the support surface 16 is larger than the largest diameter of the front surface 24 in order to minimize the wear from chips on the joint between the drill tip and the drill body. The drill body also includes curved surfaces 41A forming lands. The front surface 24 is substantially planar but comprises a projection 60 at the transition between the front surface 24 and the jacket surface of each land 41A. The height of the projection is somewhat less than that of the depth of the recess 50.

Each projection 60 comprises a first free or end surface 61 perpendicularly connected to the jacket surface 41A, said surface 61 also perpendicularly connected to a second free surface 62, which in its turn forms an acute angle π with a first guiding surface 63. The surface 63 connects to a second guiding surface 64 oriented parallel to the rotational axis 22. The surface 64 connects to the front surface 24 via a radius 65. The surface 63 is oriented parallel to the surface 53 so as to face generally radially outwardly and longitudinally forwardly.

The projection 60 has a stop surface 66, Fig. 9, which is parallel with the axis 22 and which suitably lies in an axial plane which contains said axis.

The smallest diameter of the front surface 24 is
5 smaller than the largest diameter of the drill tip but
larger than the smallest diameter of the drill tip. The
projection 60 extends in a tangential direction from the
chip flute 18A to about the midpoint of the
circumferential tangential length G' of the associated
10 land 41A.

The stop surfaces 56 and 66, respectively, should
be as far from the rotational axis as possible for best
moment transfer, i.e. they are arranged diametrically
15 opposed each other. The drill tip must be symmetrically
formed in order to retain the tool's concentricity at
varying strain, i.e. in order to keep the drill tip
centered relative to the drill body. The projections 60
and the recesses 50 lie at a distance from and
substantially rearwardly of the associated cutting
20 edge 19 in the tool's rotational direction R.

Mounting of the drill tip 11 on the drill body 12
is done as follows. The drill tip 11 is brought in the
axial direction towards the drill body 12, so that each
projection 60 is received in the associated chip flute 18
25 and so that the support surface 16 abuts against the front
surface 24. Then, the drill tip is rotated in the
direction R within an angle interval ϕ which is less than
360°, preferably less than 60°, relative to the drill body
so that each projection 60 moves with a slide fit in the
30 respective recess 50 until the stop surfaces 56 and 66
abut against each other. The drill tip 11 is now anchored
in the drill body 12 in a satisfactory manner. Thus, the
preformed spaces defined by the chip flutes 18 are used as
the entrance and the exit of the bayonet coupling.

When the drill tip 11 must be replaced, the mounting procedure is reversed. The drill tip 11 then can be removed from the drill body 12 and be exchanged, preferably with the aid of a suitable key in engagement with the chip flutes on the drill tip. The key is preferably also used during mounting of the drill tip.

The surfaces which during the drilling operation must be in engagement are surfaces 53 and 63 as well as the support surface 16 and the front surface 24. The surfaces 53 and 63 cooperate to hold the drill tip such that it cannot loosen in the feed direction, for example during retraction of the tool. The surfaces 53 and 63 are preferably designed such that their cooperation results in some elastic deflection of the projection 60 due to the slide fit. A limited contact surface between surfaces 54 and 64 can be allowed, but this implies an increased moment at the radius 65. The drill tip is self-centering in the tool body, i.e. it moves such that its axis coincides with the rotational axis 22 if it has been displaced during the machining operation. The surface 55 will allow the radius 65 of the tool body to be relatively large. The surfaces 52 and 62 should not be in engagement with each other during the machining operation. That is realized by extending the surface 53 (see Fig. 6). The clearance surfaces 51 and 61 should not be in engagement with each other during the machining operation, and therefore a gap P is always present between them (see Fig. 6). The gap P is in the range of 0.1 - 1.0 mm. The support surface 16 will be pressed by the feed force against the front surface 24 during the machining operation, which means that the elastic deflection of the projection 60 tends to decrease somewhat, which however is counteracted because the projection 60 will be bent radially inwardly due to pressure on the front surface 24 from the feed force.

The invention is useable also for milling cutters. The drill tip is preferably coated with layers of, for example, Al_2O_3 , TiN and/or TiCN. In certain cases, it can be well-founded to apply super hard material such as CBN or PCD on the cutting edges. Alternatively ceramic material can be used at injection molding of the drill tips.

10 Although the present invention has been described in connection with a preferred embodiment thereof, it will be appreciated by those skilled in the art that additions, modifications, substitutions and deletions not specifically described may be made without departing from the spirit and scope of the invention as defined by the appended claims.

WHAT IS CLAIMED IS:

1. A rotary metal-cutting tool comprising, in combination, a tool body and a cutting portion attached to the tool body;

the tool body including: a shank portion defining a longitudinal center axis, a front surface, and rear chip flutes formed in an external side surface of the shank for guiding chips rearwardly during a cutting operation;

10 the cutting portion including: a rear support surface abutting the front surface, a front cutting surface, and front chip flutes formed in a side surface of the cutting portion and intersecting the cutting face to form cutting edges therewith;

15 the tool body and cutting portion being
interconnected by a bayonet coupling formed by
projections disposed on one of the tool body and
cutting portion, and recesses formed in the other
of the tool body and cutting portion, the
20 projections being circumferentially offset with
respect to the flutes and extending generally
longitudinally; the recesses extending
circumferentially from respective flutes; the
flutes sized to longitudinally receive respective
25 projections during longitudinal insertion or
removal of the cutting portion relative to the
tool body; the cutting portion being rotatable
about the center axis relative to the tool body
to transfer the projections from the respective
flutes into the recesses while bringing the front
30 and rear flutes into mutual alignment.

2. The tool according to claim 1 wherein the recesses are formed in the cutting portion; and the projections are formed in the tool body.

3. The tool according to claim 1 wherein the recesses are formed in the outer surface of the cutting portion; the cutting portion being rotatable relative to the tool body by an angle less than 360 degrees.

4. The tool according to claim 3 wherein the angle is less than 60 degrees.

5. The tool according to claim 1 wherein each of the projections includes a first surface inclined obliquely relative to the center axis, the first surface facing generally radially inwardly and longitudinally rearwardly; each of the recesses including a second surface inclined obliquely relative to the center axis, the second surface facing generally radially outwardly and longitudinally forwardly and opposing a respective first surface to prevent relative longitudinal movement of the cutting portion relative to the tool body.

10 6. The tool according to claim 5 wherein a material from which the tool body is formed has a lower Young's modulus than a material from which the cutting portion is formed, to enable the projections to bend elastically in a radial direction during relative rotation between the cutting portion and tool body.

7. The tool according to claim 1 wherein each of the projections includes a first surface inclined obliquely relative to the center axis, the first surface facing generally radially inwardly and longitudinally rearwardly; each of the recesses including a second surface inclined obliquely relative to the center axis, the second surface facing generally radially outwardly and longitudinally forwardly and opposing a respective first surface to prevent relative longitudinal movement of the cutting portion relative to the tool body.

8. The tool according to claim 6 wherein the outer surface of the cutting portion defines a pair of lands extending circumferentially by equal distances between the front flutes, each of the recesses extending circumferentially for a distance of about one-half of the circumferential distance of a respective land, each of the projections extending circumferentially a distance substantially equal to that of a respective recess.

9. The tool according to claim 1 wherein each of the projections includes a first surface inclined obliquely relative to the center axis, the first surface facing generally radially inwardly and longitudinally rearwardly; each of the recesses including a second surface inclined obliquely relative to the center axis, the second surface facing generally radially outwardly and longitudinally forwardly and opposing a respective first surface to prevent relative longitudinal movement of the cutting portion relative to the tool body.

10. The tool according to claim 1 wherein each of the projections includes a forwardly facing end surface, and the recess includes a forwardly facing end surface, and the recess includes a rearwardly facing end surface spaced from the forwardly facing end surface by a gap.

11. A cutting portion adapted to be connected to a tool body for rotary metal cutting, comprising a front cutting surface having at least one cutting edge, a rear support surface, and at least one chip flute formed in a side surface of the cutting portion for guiding cuttings, said cutting portion including coupling means defining part of a bayonet coupling adapted to connect a tool body with the cutting portion.

12. The cutting portion according to claim 11 wherein the coupling means comprises a recess extending circumferentially less than 60 degrees.

13. A tool body adapted to support a cutting portion for metal cutting, the tool body including a shank, flutes formed in an outer periphery of the tool body for guiding chips, a front surface, and coupling means defining part of a bayonet coupling adapted to connect a cutting portion to the tool body.

14. The tool body according to claim 13 wherein the coupling means comprises projections spaced diametrically from one another.

15. A method for mounting a cutting portion to a tool body to form a metal-cutting rotary tool; the tool body including a shank portion; a front surface, and rear chip flutes formed in an outer surface of the tool body; 5 the cutting portion including a support surface abutting the front surface, a cutting surface having cutting edges, and front chip flutes formed in an outer surface of the cutting portion; one of the tool body and cutting portion including longitudinal projections, and the other of the tool body and cutting portion including circumferential recesses, each recess communicating with a respective flute and extending less than 180 degrees; the method 10 comprising the steps of:

15 A) converging the cutting portion and tool body longitudinally toward one another to bring the projections into respective ones of the flutes that communicate with the circumferential recesses; and

20 B) effecting relative rotation between the tool body and cutting portion to cause the projections to enter respective ones of the recesses to bring the front flutes into alignment with the rear flutes, and to bring a stop surface of each projection into longitudinally opposing relationship with a stop surface of a respective recess for defining a bayonet connection 25 preventing longitudinal displacement of the cutting portion relative to the tool body.

Abstract of the Disclosure

A tool includes a tool body and a cutting portion detachably mounted thereon, the tool being rotatable about a longitudinal center axis. The tool body includes flutes formed in an outer surface thereof, and a pair of forward projections at a front end thereof. The cutting portion includes front flutes formed in an external side thereof, and a pair of recesses extending circumferentially in communication with respective ones of the front flutes.

To connect the cutting portion to the tool body, the cutting portion and tool body are converged longitudinally so that the projections enter the front flutes. Then, relative rotation is produced between the cutting portion and tool body to align the front flutes with the rear flutes while causing the projections to enter the recesses and form therewith a bayonet coupling.

**COMBINED DECLARATION AND POWER OF ATTORNEY
FOR UTILITY PATENT APPLICATION**

Attorney's Docket No.

024444-424

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;
I BELIEVE I AM THE ORIGINAL, FIRST AND SOLE INVENTOR (if only one name is listed below) OR AN
ORIGINAL, FIRST AND JOINT INVENTOR (if more than one name is listed below) OF THE SUBJECT MATTER
WHICH IS CLAIMED AND FOR WHICH A PATENT IS SOUGHT ON THE INVENTION ENTITLED:

TWO-PIECE ROTARY METAL-CUTTING TOOL AND

METHOD FOR INTERCONNECTING THE PIECES

the specification of which

COPY

(check one)

is attached hereto;

was filed on September 15, 1997 as

Application No. _____

and was amended on _____;
(if applicable)

I HAVE REVIEWED AND UNDERSTAND THE CONTENTS OF THE ABOVE-IDENTIFIED SPECIFICATION,
INCLUDING THE CLAIMS, AS AMENDED BY ANY AMENDMENT REFERRED TO ABOVE;

I ACKNOWLEDGE THE DUTY TO DISCLOSE TO THE OFFICE ALL INFORMATION KNOWN TO ME TO BE
MATERIAL TO PATENTABILITY AS DEFINED IN TITLE 37, CODE OF FEDERAL REGULATIONS, Sec. 1.56
(as amended effective March 16, 1992);

I do not know and do not believe the said invention was ever known or used in the United States of America before
my or our invention thereof, or patented or described in any printed publication in any country before my or our
invention thereof or more than one year prior to said application; that said invention was not in public use or on sale in
the United States of America more than one year prior to said application; that said invention has not been patented or
made the subject of an inventor's certificate issued before the date of said application in any country foreign to the
United States of America on any application filed by me or my legal representatives or assigns more than twelve
months prior to said application;

I hereby claim foreign priority benefits under Title 35, United States Code Sec. 119 and/or Sec. 365 of any foreign
application(s) for patent or inventor's certificate as indicated below and have also identified below any foreign
application for patent or inventor's certificate on this invention having a filing date before that of the application(s) on
which priority is claimed:

COMBINED DECLARATION AND POWER OF ATTORNEY			Attorney's Docket No. 024444-424																																																																								
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<p>I hereby appoint the following attorneys and agent(s) to prosecute said application and to transact all business in the Patent and Trademark Office connected therewith and to file, prosecute and to transact all business in connection with international applications directed to said invention:</p> <table> <tbody> <tr><td>William L. Mathis</td><td>17,337</td><td>Ralph L. Freeland, Jr.</td><td>16,110</td><td>William C. Rowland</td><td>30,888</td></tr> <tr><td>Peter H. Smolka</td><td>15,913</td><td>Robert G. Mukai</td><td>28,531</td><td>T. Gene Dillahunty</td><td>25,423</td></tr> <tr><td>Robert S. Swecker</td><td>19,885</td><td>George A. Hovanec, Jr.</td><td>28,223</td><td>Anthony W. Shaw</td><td>30,104</td></tr> <tr><td>Platon N. Mandros</td><td>22,124</td><td>James A. LaBarre</td><td>28,632</td><td>Patrick C. Keane</td><td>32,858</td></tr> <tr><td>Benton S. Duffett, Jr.</td><td>22,030</td><td>E. Joseph Gess</td><td>28,510</td><td>Bruce J. Boggs, Jr.</td><td>32,344</td></tr> <tr><td>Joseph R. Magnone</td><td>24,239</td><td>R. Danny Huntington</td><td>27,903</td><td>William H. Benz</td><td>25,952</td></tr> <tr><td>Norman H. Stepno</td><td>22,716</td><td>Eric H. Weisblatt</td><td>30,505</td><td>Peter K. Skiff</td><td>31,917</td></tr> <tr><td>Ronald L. Grudziecki</td><td>24,970</td><td>James W. Peterson</td><td>26,057</td><td>Richard J. McGrath</td><td>29,195</td></tr> <tr><td>Frederick G. Michaud, Jr.</td><td>26,003</td><td>Teresa Stanek Rea</td><td>30,427</td><td>Matthew L. Schneider</td><td>32,814</td></tr> <tr><td>Alan E. Kopecki</td><td>25,813</td><td>Robert E. Krebs</td><td>25,885</td><td>Michael G. Savage</td><td>32,596</td></tr> <tr><td>Regis E. Slutter</td><td>26,999</td><td>Robert M. Schulman</td><td>31,196</td><td>Gerald F. Swiss</td><td>30,113</td></tr> <tr><td>Samuel C. Miller, III</td><td>27,360</td><td></td><td></td><td></td><td></td></tr> </tbody> </table>				William L. Mathis	17,337	Ralph L. Freeland, Jr.	16,110	William C. Rowland	30,888	Peter H. Smolka	15,913	Robert G. Mukai	28,531	T. Gene Dillahunty	25,423	Robert S. Swecker	19,885	George A. Hovanec, Jr.	28,223	Anthony W. Shaw	30,104	Platon N. Mandros	22,124	James A. LaBarre	28,632	Patrick C. Keane	32,858	Benton S. Duffett, Jr.	22,030	E. Joseph Gess	28,510	Bruce J. Boggs, Jr.	32,344	Joseph R. Magnone	24,239	R. Danny Huntington	27,903	William H. Benz	25,952	Norman H. Stepno	22,716	Eric H. Weisblatt	30,505	Peter K. Skiff	31,917	Ronald L. Grudziecki	24,970	James W. Peterson	26,057	Richard J. McGrath	29,195	Frederick G. Michaud, Jr.	26,003	Teresa Stanek Rea	30,427	Matthew L. Schneider	32,814	Alan E. Kopecki	25,813	Robert E. Krebs	25,885	Michael G. Savage	32,596	Regis E. Slutter	26,999	Robert M. Schulman	31,196	Gerald F. Swiss	30,113	Samuel C. Miller, III	27,360				
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<p>and: _____</p> <p>Address all correspondence to: Ronald L. Grudziecki, Esq. BURNS, DOANE, SWECKER & MATHIS, L.L.P. P.O. Box 1404 Alexandria, Virginia 22313-1404</p> <p>Address all telephone calls to: <u>Alan E. Kopecki</u> at (703) 836-6620.</p> <p>I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.</p>																																																																											
FULL NAME OF SOLE OR FIRST INVENTOR Mattias BERGLUND		SIGNATURE		DATE																																																																							
RESIDENCE Njutånger, SWEDEN		CITIZENSHIP		SWEDEN																																																																							
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FULL NAME OF SECOND JOINT INVENTOR, IF ANY Fredrik LUNDBERG		SIGNATURE		DATE																																																																							
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FULL NAME OF THIRD JOINT INVENTOR, IF ANY Ingela SVENSSON		SIGNATURE		DATE																																																																							
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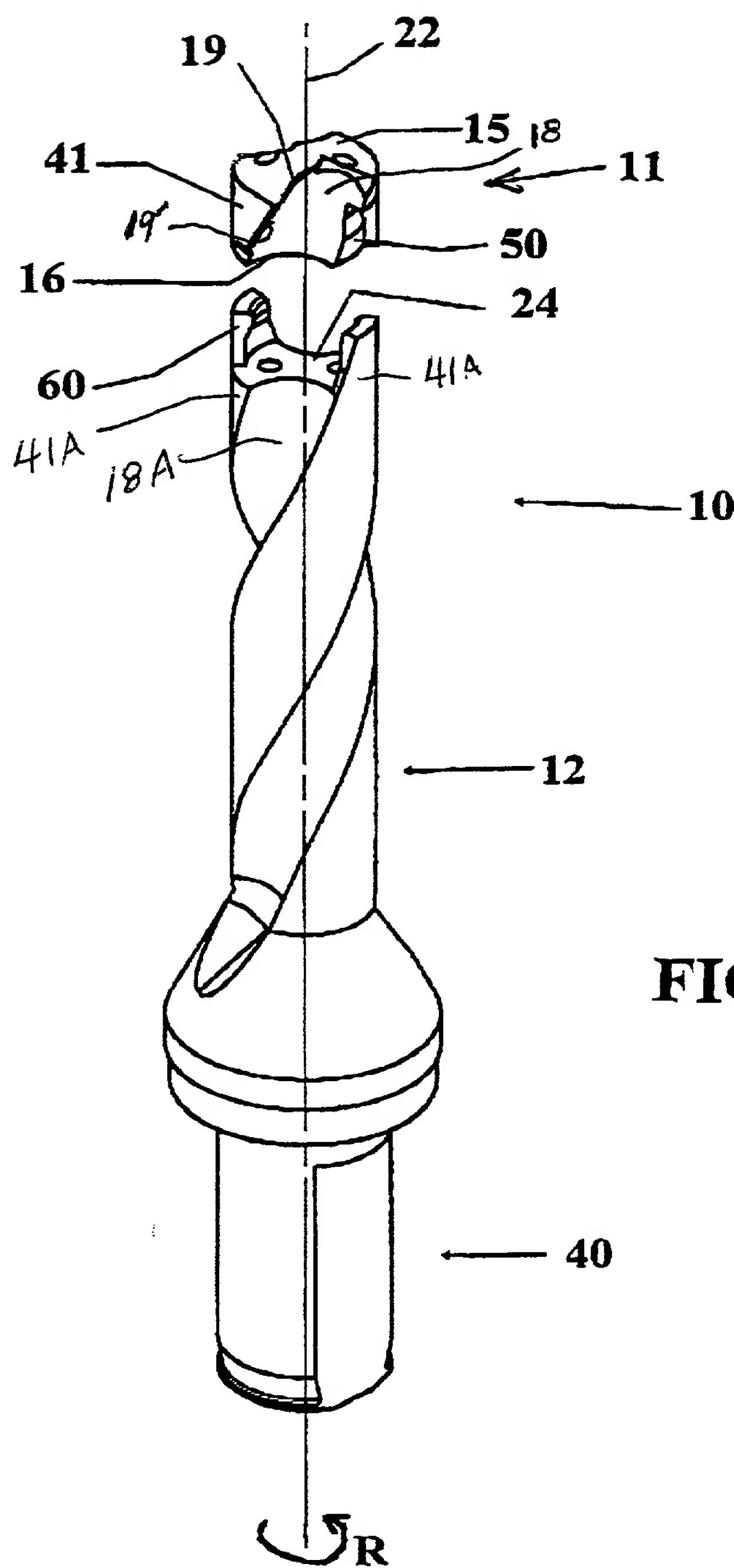


FIG. 1

Fig. 2

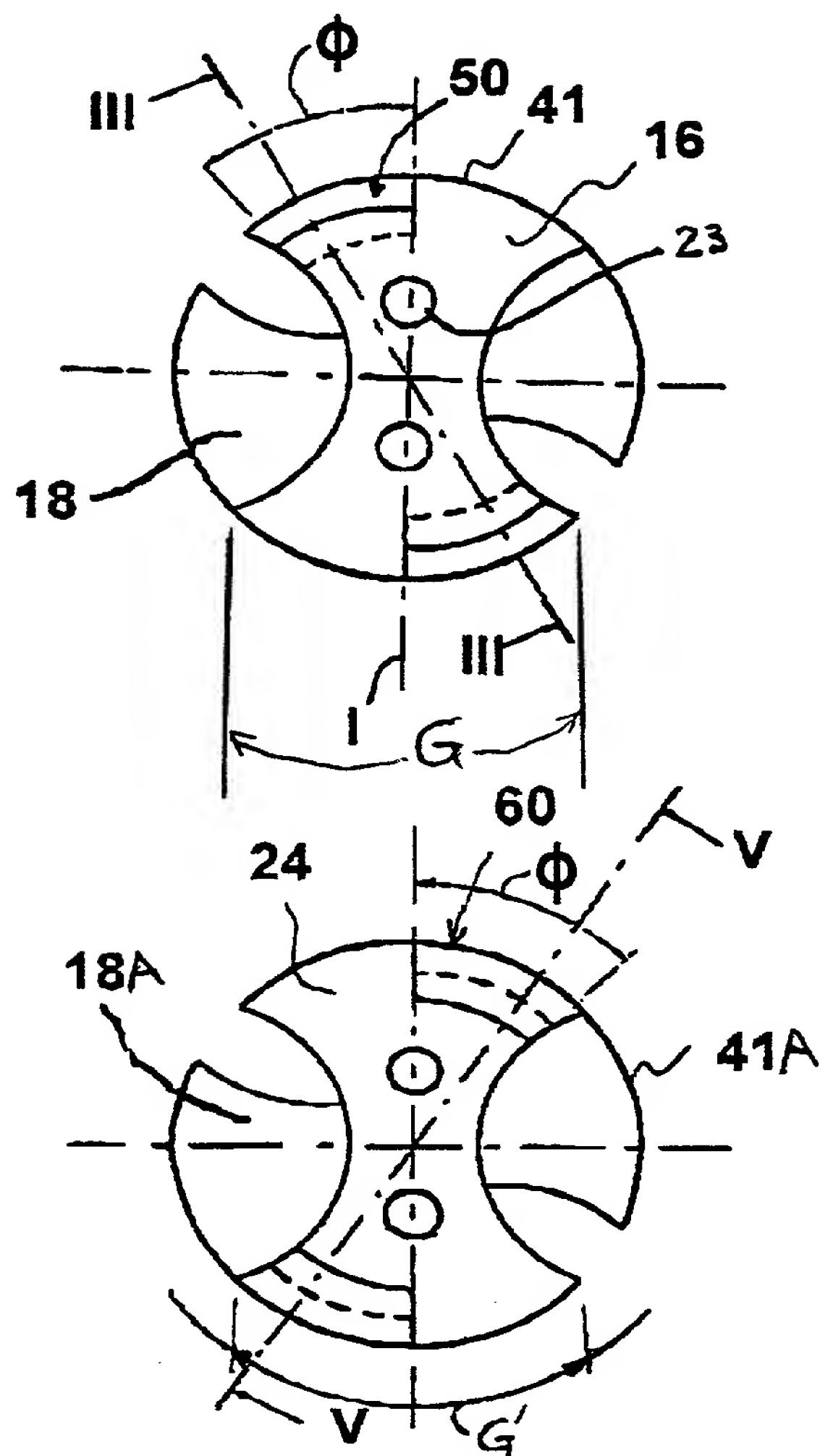


Fig. 3

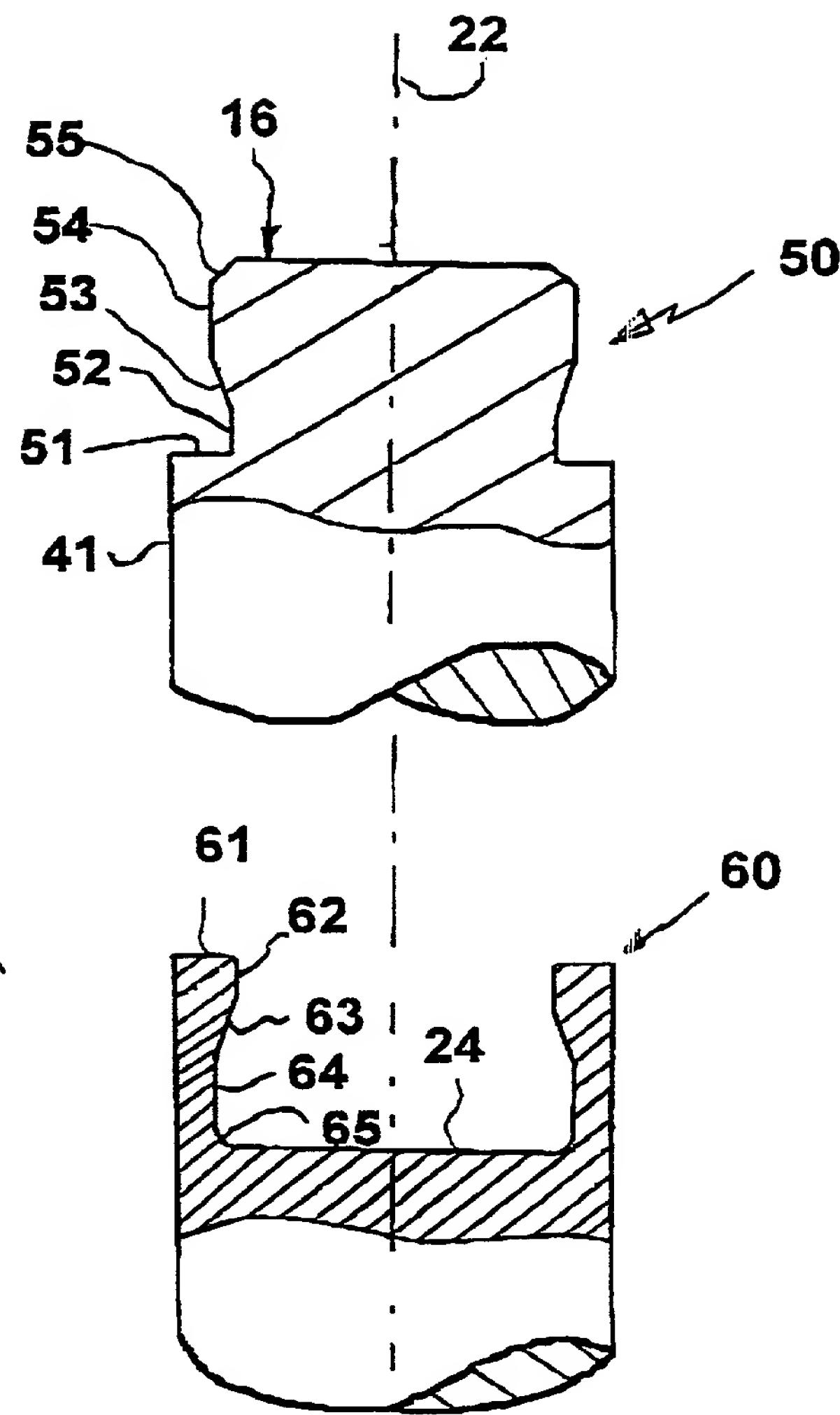


Fig. 4

Fig. 5

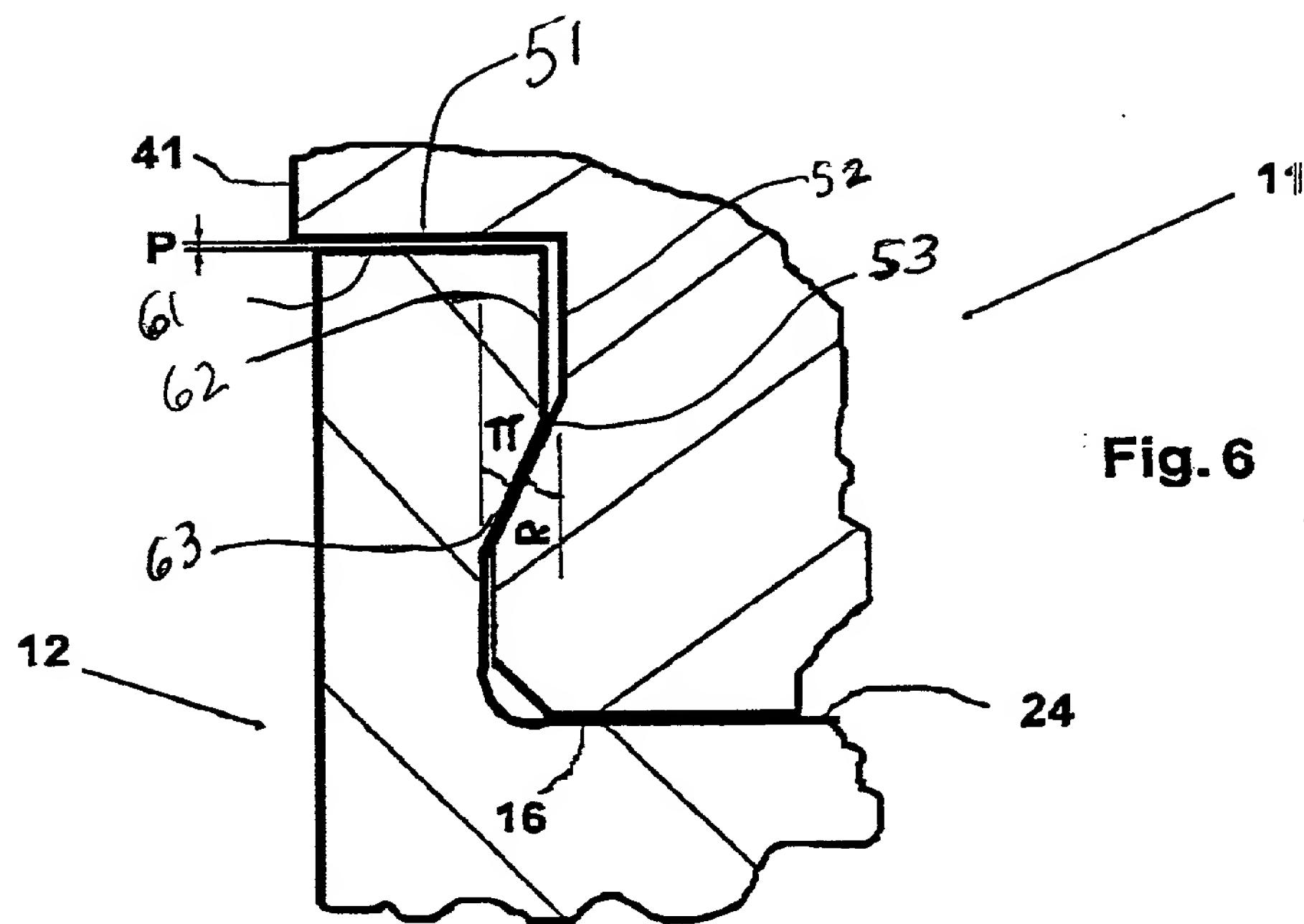


Fig. 6

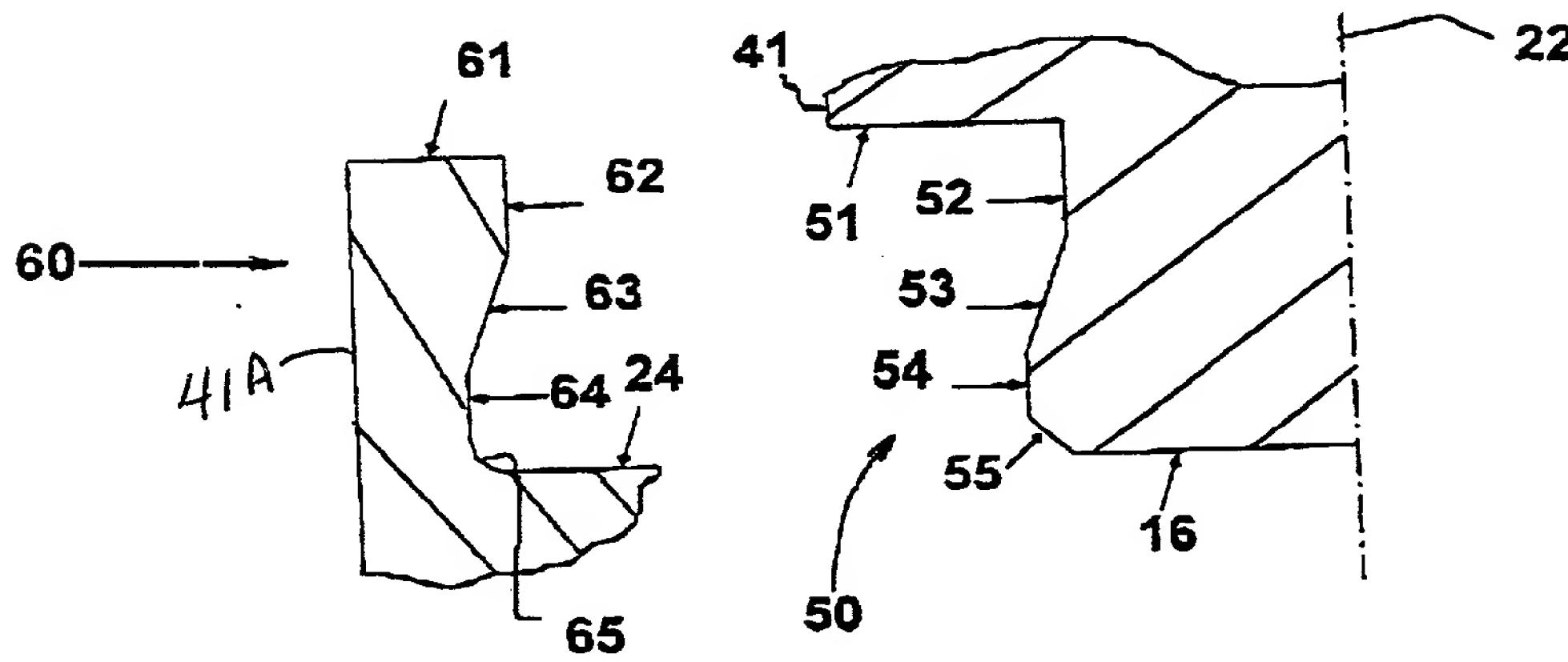


Fig. 7



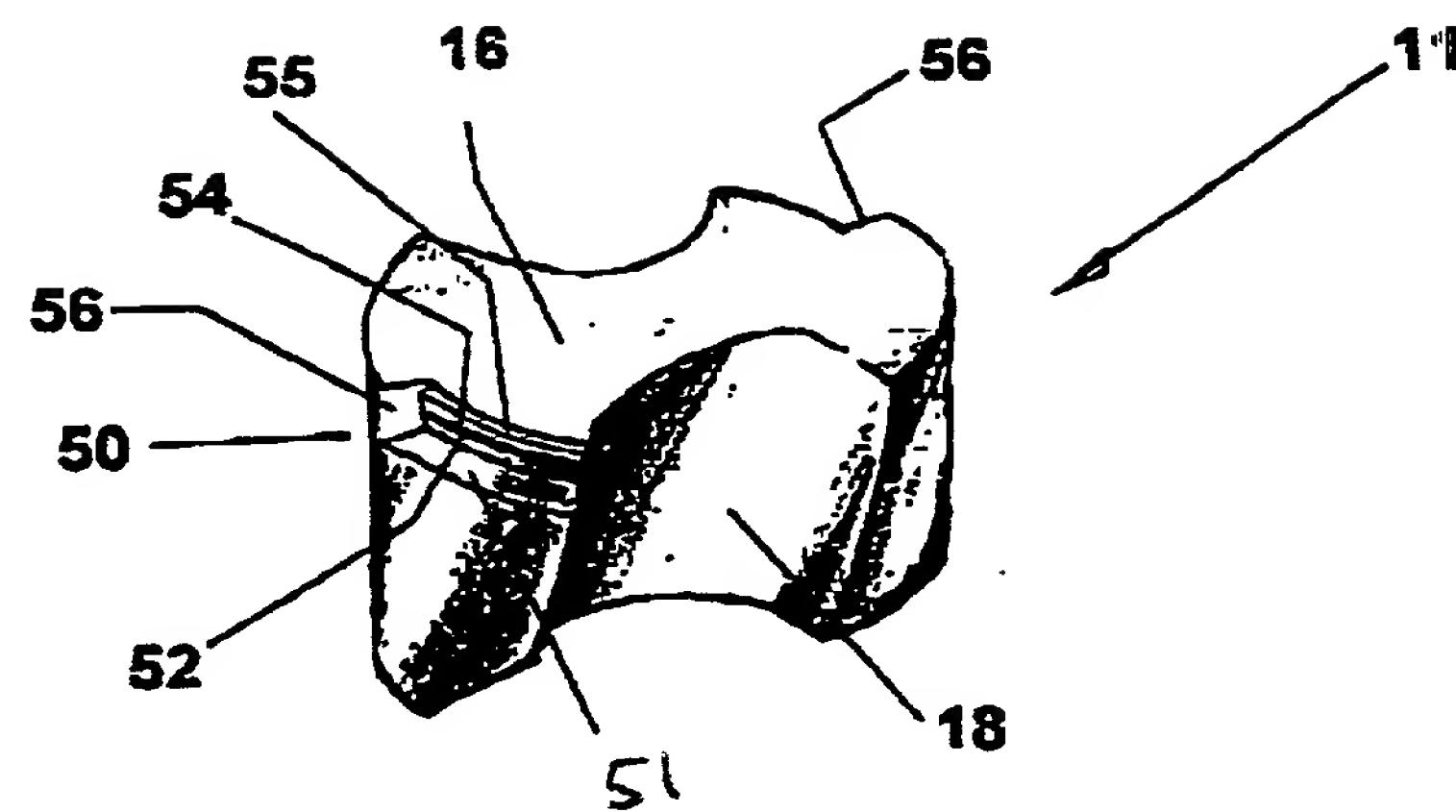


Fig. 3A

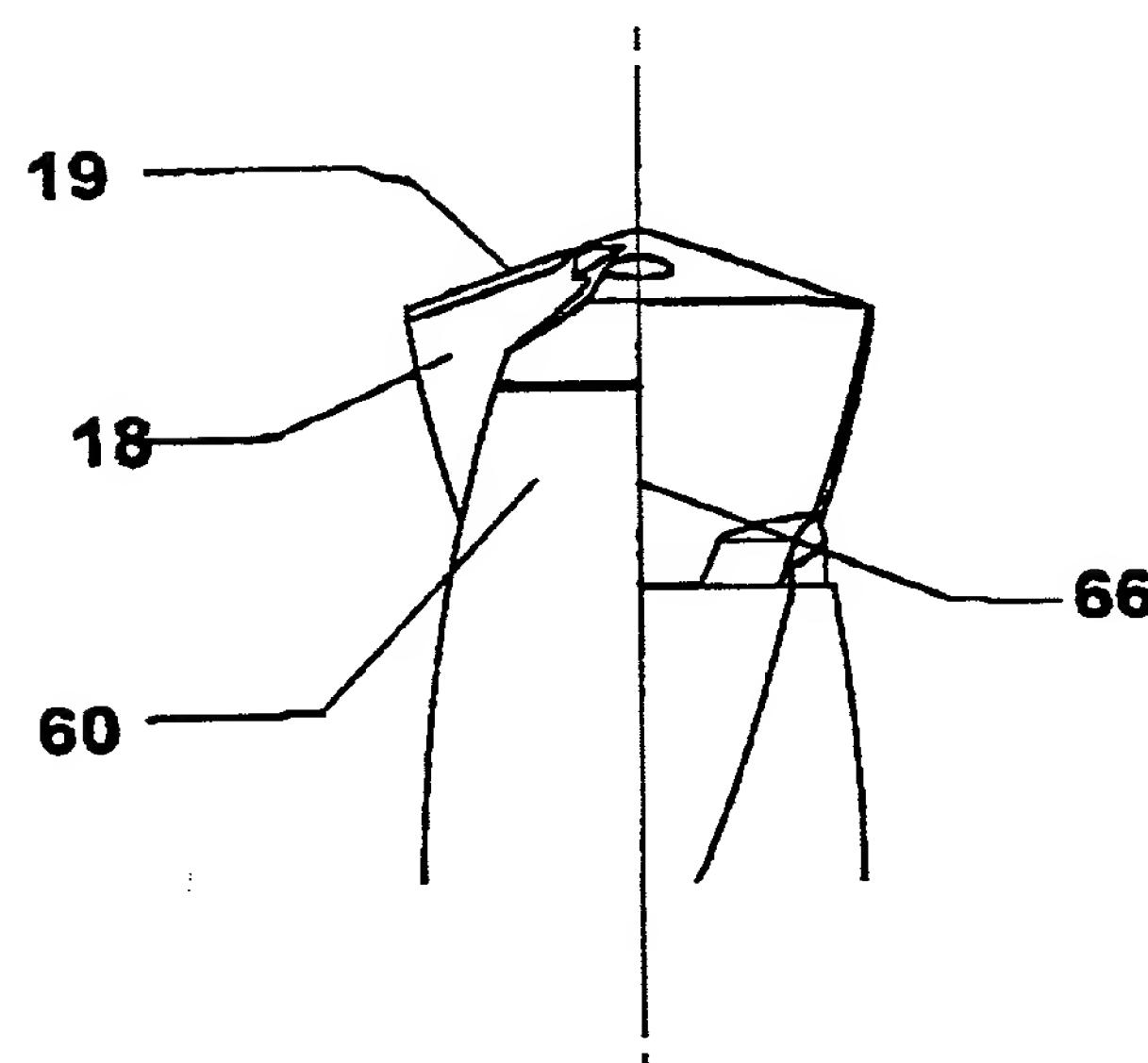


Fig. 9